GEORGE MASON UNIVERSITY

ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

SPRING 2007

ECE 699: NANOELECTRONICS

Time and location: MW 12:00 pm – 1:15 pm, ST1 Rm. 110
Instructor: Dimitris Ioannou, ST-II Rm#247, tel. 993-1580, dioannou@gmu.edu
Office Hours: MW 3:00 – 4:00 pm; other times by appointment.

Required Textbook: "Nanoelectronics and Information Technology", Edited by Rainer Waser (Wiley, 2nd Edition).

COURSE CONTENT

Nanoelectronics is a new and exciting field, which on the main deals with the question of what happens to an (electronic) device when one or more of its dimensions is in the nano-range, say in the range of 100 nm down to 1 nm. Much is known for devices with sizes larger than that (Microelectronics) and the atomic physics deals very successfully with atomic sizes (less than 1 nm). This course presents the design and analysis of a variety of nano-devices (also referred to as "mesoscopic" devices), and briefly examines some notable applications. The emphasis is on a deep understanding of the fundamental concepts and principles which apply to small devices and the challenges and opportunities ahead. A student should thus have a good grasp of introductory modern physics (as presented in a typical undergraduate EE program) and some "affinity" towards physics in general. The course is still under development and evolving, and the material has not yet settled to a point that standard textbook treatments are available. Extensive use will thus be made of chapters from various books and review papers from the literature, which will be made available on the course webpage. The required course textbook given above should thus be treated as a very good and comprehensive reference, which contains much more material than can be covered in a single course. In addition, the references listed below are useful for parts of the course and the corresponding homework assignments/projects. Some of the homework assignments/projects will require a working knowledge of MATLAB.

REFERENCE LIST

1) Lectures on the Electrical Properties of Materials, by L. Solymar and D. Walsh (Oxford Science Publications, 7th Edition).
2) Quantum Mechanics, by D.K. Ferry (Institute of Physics Publishing)
3) The Physics of Low Dimensional Semiconductors, by J.H. Davies (Cambridge)
4) Mesoscopic Electronics in Solid State Nanostructures, by T. Heinzel (Wiley-VCH)

COURSE OUTLINE

1. Schrodinger's equation (one week)
2. Tunneling (one week)
3. Resonant Tunneling Diodes (one week)
4. Single Electron Transistors (one week)
5. Quantum Dots (one week)
6. NanoWires and Carbon Nanotubes (one week)
7. Phase Coherence (Aharonov-Bohm Effect) (one week)
8. Molecular Electronics – Electronic Noses (one week)
9. Nano-scale Fabrication Techniques (one week)
10. Scanning Probe Techniques (one week)
11. Bulk and SOI Nano-CMOS (two weeks)
12. Course Review/Outlook (one week)

GRADING

Homework/projects - 20%
Midterm Exam 1 - 20%
Midterm Exam 2 - 20%
Final Exam - 40%

The dates of the Midterm exams will be announced in class at least two weeks before each exam, and will depend on the course progress.